Solution to Homework Set #18, Physics 222, by Jian Wang

Chapter 28:

Question 7:

Sunlight reflected from water, glass, etc. is partially polarized. If the surface is horizontal, the electric field vector of the reflected light will have a strong horizontal component. Therefore, in order to reduce the glare of reflected light as much as possible, the transmission axes of the polarizing material in sunglasses should be vertically oriented.

Problem 3:

The angle at which minimum occur is

$$\sin q = m\frac{l}{a}$$

where m=$\pm$1,$\pm$2,$\pm$3,.....

For small angles,

$$\sin q = \frac{y}{L}$$

Therefore,

$$\sin \Delta q = \Delta m\frac{l}{a} = \frac{\Delta y}{L}$$

$$a = \frac{\Delta m\, l L}{\Delta y} = \frac{(2)(690\times 10^{-9}\,\mathrm{m})(0.5\mathrm{m})}{3\times 10^{-3}\,\mathrm{m}}$$

$$= 2.3\times 10^{-4}\,\mathrm{m}$$

Problem 7:

As discussed in P3, we have

$$\sin \Delta q = \Delta m\frac{l}{a} = \frac{\Delta y}{L}$$

In our case, Δm=2, a=0.55mm, Δy=4.1mm, L=2.06m,

$$l = \frac{\Delta y a}{\Delta m L} = \frac{4.1\times 10^{-3}\times 0.55\times 10^{-3}}{2\times 2.06} = 547 nm$$

Problem 23:

This problem is simple. Just use the appropriate equation.

(a) Since the telescope has a circular mirror, the limiting angle of resolution of it is:

$$q_m = 1.22\frac{l}{D} = 1.22\times\frac{590\times10^{-9}}{0.3} = 2.4\times10^{-6} rad$$

(b) $d = Lq_m = 213Km$

Problem 25:

(a) The resolving power of the diffraction grating is

$$R = Nm = \frac{l}{\Delta l}$$

In our case, m=1, λ=(λ_1+λ_2)/2=531.7nm,

$$\Delta l = l_2 - l_1 = 0.19nm$$

$$N(1) = \frac{531.7}{0.19} = 2800 lines$$

(b) $\frac{1.32\times10^{-2}m}{2800} = 4.72mm$

Problem 42:

First, we derive the equation of the transmitted intensity, I.

After the first polarizing disk,

$$I_1 = I_i\cos^2 q_1$$

After the second,

$$I_2 = I_1\cos^2 q_2' = I_1\cos^2 q_1\cos^2(q_2 - q_1)$$

After the last,

$$I_f = I_2\cos^2 q_3' = I_1\cos^2 q_1\cos^2(q_2 - q_1)\cos^2(q_3 - q_2)$$

(a) θ_1=20°, θ_2=40°, θ_3=60°

$$I_f = 10\times\cos^2 20°\times\cos^2 20°\times\cos^2 20° = 6.88 units$$

(b) θ_1=0, θ_2=30°, θ_3=60°

$$I_f = 10\times\cos^2 0\times\cos^2 30°\times\cos^2 30° = 5.63 units$$